REMARKS

Applicants respectfully request reconsideration of the pending application in view of the foregoing amendments and the following remarks.

Status of the Application

Claims 1, 3-9, 13 and 15-21 are currently pending. In this response, 1, 3-7, 9 and 13 are amended and claims 2, 10-12 and 14 are canceled without prejudice. In addition, claims 15-21 are new. As the subject matter of the amended claims is fully supported by the application as filed, no new matter has been introduced into the application by way of these amendments. For example, support for new claims 15-19 can be found on pages 16, 17, 19, 21, 24, and 25, among others, of the application as filed.

Summary of the Office Action

The Office Action opens by objecting to the specification as containing numerous typographic errors.

The Office Action continues by objecting to claims 1, 4, 5, 7, 9, 10 and 14 under 37 CFR 1.75(a) as lacking antecedent basis and, further, as containing a typographical error (claim 14).

Claims 11 and 12 are rejected under 35 U.S.C. § 101 as being directed to non-statutory subject matter.

Claims 1, 3, 8, 9, 11 and 13 are rejected under 35 U.S.C. 102(b) as being anticipated by Chang et al., *Radiology Image Orientation Processing for Workstation Display*, Part of the SPIE Conference on Image Display, SPIE Vol. 3335, 285-296 (February 1998) ("Chang"), which references Glicksman et al., *Architecture of a High Performance PACS Based on a Shared File System*, SPIE Vol. 1654 Medical Imaging VI: PACS Design and Evaluation, 158-168 (1992) (hereinafter "Glicksman").

Claims 2, 6, 10, 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Chang and Kawata et al., *Characteristics Measurement for Blood Vessels Diseases Detection Based on Cone-Beam CT Images*, Nuclear Science Symposium and Medical

Imaging Conference Record, 1660-1664 (Copyright 1996) (hereinafter "Kawata"), which references Sander et al., *Inferring Surface Trace and Differential Structure from 3-D Images*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 12, No. 9, 833-854 (September 1990) ("Sander").

Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Chang and Kawata in further view of U.S. Publication No. 2003/0215119 ("Uppaluri").

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Chang and Kawata in further view of U.S. Patent No. 5,572,565 issued to Abdel-Mottaleb ("Abdel-Motaleb").

Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over the combination of Chang and Pietka, Image Standardization in PACS, Handbook of Medical Imaging, 783-801 (Academic Press, 2000) ("Pietka").

Finally, claims 1, 7, 8, 9, 11 and 13 are provisionally rejected under a judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 10, 11, 13, 14 and 15 of co-pending U.S. Application Serial No. 10/774,943 ("the '943 application").

Discussion

The subject matter of the present application pertains generally to a method of determining the orientation of an image, such as a thoracic or mammographic radiographic image. More particularly, claims 1, 3-9 and 13, as amended, as well as new claims 15, 16, 18 and 19, require determining image orientation from direction and magnitude of normal vectors taken at points along the image with a given curvature. New independent claim 17 requires fitting a circle segment to an edge representation of the image and determining the image orientation as the direction of the midpoint of the fitted circle segment towards the circle center. As discussed in more detail below, none of the cited references teach, expressly or inherently, the use of normal vector directions or magnitudes along the image curvature for determining image orientation.

Specifically, the image orientation algorithm of Chang does not employ direction of normal vectors or the image curvature to determine the image orientation. Similarly, both Kawata and Sander are silent as to using curvature to determine image orientation. Instead, Kawata uses curvature properties for purposes of identifying shapes to assist in a medical diagnosis, while Sander teaches surface classification of 3-D images according to Gaussian and mean curvatures. The remaining references cited in the Office Action do not, alone or in combination, remedy the defects of Chang, Kawata, and Sander.

Furthermore, with respect to the new independent claim 17, the cited references contain no teaching, express or inherent, of determining image orientation as the direction of the midpoint of a circle segment, fitted to an edge representation of an image, toward the circle center.

Applicants also submit that the claim amendments presented in this response address the Section 101, provisional double patenting, as well as the remaining claim rejections and objections set forth in the Office Action, and place the application in condition for allowance with respect to those rejections and/or objections. As requested on page 3 of the Office Action, Applicants amended the specification on page 19, line 16 to insert a reference to Figure 5. This amendment further clarifies that the associated description is part of the overall description of the orientation detection algorithm example associated with the lung image of Figure 5, which begins on page 18, line 31. Similarly, on page 22, line 37 and page 23, line 2 of the specification, Applicants inserted references to Figures 6B, 6C and 6D associated with LCC, RMLO, and LMLO views referred to in the corresponding text.

The Anticipation Rejections

Independent claim 1, as well as its dependent claims 3, 8, 9, 11 and 13 are rejected under 35 U.S.C. 102(b) as being anticipated by Chang, which references Glicksman. As indicated above, dependent claim 11 has been canceled in this Amendment without prejudice.

The present Application uses normal vector and curvature computations for a digital image, in the context of differential geometry, to determine image orientation. Specifically, as

amended, claim 1 requires determining image orientation based on "direction and magnitude of normal vectors associated with local curvature in a set of points" of a digital representation of the image. See, e.g., Application, page 15, lines 26-28; page 16, lines 25-26. Direction of a given normal vector at a point along the image is determined by computing the direction of a "subtraction vector" (or "addition vector") of chord vectors located at equal arc distance from the point along the image boundary. See, e.g., Application, page 16, lines 17-26. To determine image orientation, the present application determines a coordinate system quadrant in which a given point's normal vector lies, collects a histogram of "votes" of normal vectors for each quadrant, weighs quadrant votes by value of image curvature at a given point (to indicate orientation's strength), and determines the overall image orientation based on the quadrant or quadrants with the highest votes of normal vectors. See, e.g., Application, page 16, lines 1-15.

Chang describes a radiology image orientation processor for performing automated object/shape classification and image orientation of digital X-ray images. See Chang, Introduction section, at page 285. The image processor of Chang first classifies the type of body part depicted in the X-ray image (e.g., chest vs. abdomen image) and then performs a body-part-specific procedure to determine the proper orientation. "If the type of image is 'Chest' or 'Abdomen', the orientation processor will first verify the image type and then return orientation." See Chang, at page 286. To determine image orientation, the processor of Cheng tests a number of conditions specific to a given image type. See Chang, Figure 6. For a chest X-ray, if a body touches four sides of the image, the processor performs a series of tests to determine whether the image is a front or side image. Id. For example, if both left and right body boundaries are smooth, then the image is determined to be a side chest X-ray, however if both left and right boundaries are rough, the image is a front chest X-ray. See Cheng, Figure 6, second and third boxes. "If the image is determined to be a front image, the algorithm determines the patient's orientation based on the percentages of the bright pixels of each side of the segmented image." See Cheng, page 289, lines 2-3.

Thus, contrary to the requirement of claim 1, Cheng is silent as to the use of image curvature and normal vector properties to determine image orientation. In fact, the orientation processor of Chang does not rely on differential geometry properties of image shapes, including

curvature and normal vector direction and magnitude computations, to determine image orientation. Likewise, Glicksman, in addition to improperly forming part of a Section 102 rejection due to being a distinctly separate reference located in a different volume of the SPIE publication, merely discloses a computer system architecture for high performance Picture Archiving and Communications System (PACS). Therefore, neither Cheng, nor Glicksman, teach determining image orientation based on "direction and magnitude of normal vectors associated with local curvature in a set of points" of a digital representation of the image, as required by independent claim 1 and dependent claims 3-9, 13, 15, 16, 18 and 19.

The Obviousness Rejections

Claims 2, 6, 10, 12 and 14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Chang and Kawata, the latter referencing Sander. Claim 4 is rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Chang and Kawata in further view of Uppaluri. Claim 5 is rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Chang and Kawata in further view of Abdel-Motaleb. Finally, claim 7 is rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Chang and Pietka.

As previously indicated, dependent claims 2, 10, 12 and 14 have been canceled without prejudice by way of this Amendment, and thus are not addressed herein. The remaining claims subject to the section 103 rejection, namely dependent claims 4, 5, 6 and 7, all depend from independent claim 1, as amended, and incorporate the requirements of that claim. Therefore, claims 4-6 and 7 all require determining image orientation based on "direction and magnitude of normal vectors associated with local curvature in a set of points" of a digital representation of the image.

As discussed above, Chang does not, expressly or inherently, teach the aforementioned requirement. Similarly, Kawata is silent regarding the use of curvature and normal vector computations to determine image orientation. Instead, Kawata discusses use of curvature computations in the context of identifying images of blood vessels having potentially problematic shapes indicative of a blood vessel disease (e.g., detecting surface shapes on an

aneurysm like a blob and on a stenosis). See Kawata, page 1661, right column; Conclusion section. To identify potentially problematic blood vessel shapes, Kawata employs segmentation of blood vessel surfaces using signs of Gaussian and mean curvatures. Id. Kawata is also silent as to the use of direction and magnitude of normal vectors of the image points to determine image orientation.

Sander employs curvature computations in the context of surface classification and is similarly devoid of any teaching, express or inherent, directed to use of curvature and/or normal vector direction and magnitude to obtain image orientation. See Sander, page 839, Figure 5 ("Surface point P is classified as (a) elliptic, (b) hyperbolic, or (c) parabolic according to its Gaussian and mean curvatures."). The Office Action alleges that Sander teaches first and second derivative vectors as values "a," "b," and "c" on the line following equation (1) on page 839. The Applicant respectfully disagrees with this assertion. Equation (1) in Sander describes a "parabolic quadric surface" where "a," "b," and "c" are second partial derivatives representing quadric parameters of a parabolic quadric surface equation (i.e., equation (1)). See Sander, page 839, left column, section A, second paragraph; section B, first paragraph. In fact, Sander teaches away from using magnitude information related to normal vectors because "surface normal information is ignored" since "the magnitudes arise from different processes and must be normalized away since they are incommensurable" (i.e., their influence is eliminated). See Sander, page 839, right column, last full paragraph. The Office Action also points to equations (2) and (3) on page 839 of Sander as allegedly representing quantizing the direction and magnitude of computed first and second derivative vectors. See Office Action, page 11. The Applicant respectfully disagrees with this characterization. In accordance with Applicant's understanding, equations (2) and (3) merely represent parabolic equalities used to estimate the quadric surface parameters a, b, and c. See Sander, page 839, right column, first paragraph.

Therefore, neither Chang, nor Kawata or Sander, either along or in combination, teach or suggest determining image orientation based on "direction and magnitude of normal vectors associated with local curvature in a set of points" of a digital representation of the image, as required by claims 4-6 and 7. The remaining references, Uppaluri, Abdel-Motaleb, and Pietka do not remedy the deficiencies of Chang, Kawata, and Sander.

Provisional Double Patenting Rejections

Claims 1, 7, 8, 9, 11 and 13 are provisionally rejected under a judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1, 10, 11, 13, 14 and 15 of the '943 application. As discussed above, claim 11 has been canceled without prejudice by way of this Amendment.

With respect to the remaining claims subject to the provisional double patenting rejection, these claims, as amended, now require determining orientation of an image based on "direction and magnitude of normal vectors associated with local curvature in a set of points" of a digital representation of the image. In contrast, claims 1, 10, 11, 13, 14 and 15 of the '943 application are directed to a patentably distinct way of determining orientation of a radiographic image. Namely, "on the basis of an extreme value (maximum, minimum) of the calculated moments" of a digital signal representation of the image. Based on the foregoing claim amendments, Applicants respectfully request that the provisional double patenting rejection be wtihdrawn.

Conclusion

As Applicants believe the application is in proper condition for allowance, the examiner is respectfully requested to pass the application to issue. If, in the opinion of the Examiner, a telephone conference would expedite the prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

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